Designing Simple Tools for Socially Shared Regulation: Experiences of Using Google Docs and Mobile SRL Tools in Mathematics Education

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Abstract: The aim of this paper is to describe how simple SRL tools can be used for supporting collaborative learning in the context of a mathematics education course. In particular, we will first introduce the pedagogical design building on a theoretical framework of socially shared regulation of learning (SSRL) and seamless learning. Second, we will introduce simple tools that were used at different points of the collaborative task to increase teacher and student awareness of situation-specific regulation. Third, we will provide case examples to illustrate how the collaborating groups with varying profiles benefit from use of the tool in practice. The results show that highly self-regulating collaborating groups saw the added value of the tool designed to support SSRL. However, the collaborating groups with low levels of self-regulation felt that it was merely an additional tool which needed to "'perform".

Keywords: socially shared regulation, regulation tools, web2.0, mathematics, teacher education

Introduction

During recent years, methodological and technological developments in information and communication technologies have changed the ways in which people communicate, collaborate and learn in fundamental ways. Yet merely providing opportunities to use technology is not enough to guarantee deep learning (Järvelä & Hadwin, 2013). Recently, Laru, Naykki, & Järvelä (2014) carried out an analysis of ubiquitous technologies use in educational contexts, and they concluded that more pedagogically grounded instructional design is needed. In particular, effort is needed to put emergent technologies to effective use in promoting learning skills, namely self-regulated learning and collaborative learning, in order to train people with 21st century skills.

Personal, portable and wirelessly networked technologies are becoming more prevalent in the lives of learners, while the development of social media has simultaneously led to new ideas about what it means to participate in educational activities. The interplay between Web 2.0 tools and mobile technologies, as well as the interplay between individual and collective activities is setting new challenges for supporting collaborative learning, as teachers have to integrate these new technologies into more or less traditional learning methods, curricula and everyday school life. On a more general level, a major challenge in the technology enhanced learning field is overemphasis on designing tools and instructional activities for sharing and communicating, while the potential role of tools and appropriate instructional design for guiding and supporting learning processes has been virtually ignored (Järvelä & Hadwin, 2013).

More recently researchers have started to explore how mobile devices, social media or personal learning environments can support or promote self-regulated learning (Kitsantas & Dabbagh, 2011). In a continuation of these research efforts Laru & Järvelä (2014) have developed a pedagogical framework for seamless learning based on the levels of interactivity and self-regulation of learning that different tools and activities enable. The pedagogical framework bridges the gaps between individual and collaborative activities as well as face-to-face and mobile social media activities. The ultimate aim is to promote active learning by facilitating interaction and sharing for engaged learning (Järvelä & Renninger, 2014). Recently, Järvelä et al. (2014) introduced design principles for CSCL tools, enhancing socially shared regulation of learning in collaborative groups. The current paper is based on these theoretical ideas and is a part of larger research project named PROSPECTS (Investigating and Promoting Individual and Socially Shared Regulation of Learning in Primary School and Teacher Education Contexts) (See e.g. Järvelä et al., 2014). In the PROSPECTS project one of the objectives has been to study how to support teacher education on students' effective regulation of learning with regulation tools, during collaborative learning. One of the guidelines in the project is that various forms of technology can be used to increase students' awareness of their regulatory processes and stimulate their cognitive, motivation, and emotion regulation to better achieve their learning goals (Järvelä et al., 2014; Järvenoja & Järvelä, 2009). Furthermore, by harnessing technology to support self and socially shared

regulation of learning, the technology can be channeled to scaffold learners' regulation processes and help students to understand how they learn (Järvelä et al., 2014).

Aim

The aim of this paper is to describe how simple SRL tools can be used to support collaborative learning in the context of a mathematics education course. In particular, we will first introduce the pedagogical design, building on our earlier empirical research and the theoretical framework of SSRL (Hadwin, Järvelä, & Miller, 2011) and seamless learning (Laru & Järvelä, 2014). Second, we will introduce the simple tools which were used at different points of the collaborative task to increase teacher and student awareness of situation-specific regulation. Third, we will provide case examples to illustrate how the collaborating groups benefit from the tool use in practice. These case examples were selected for analysis using extreme case sampling. The idea of extreme case sampling is to select information-rich cases that could increase the depth of understanding rather than providing empirical generalizations (Patton, 2002).

Theoretical background

Regulated learning involves effective strategy use in order to regulate aspects of learning individually, with peers and among groups (Järvelä & Hadwin, 2014; Winne, Hadwin, & Perry, 2011). Successful learners use a repertoire of strategies—cognitive, behavioral and motivational—to guide and enhance their learning processes while completing academic tasks (Schunk & Zimmerman, 2008). It is often assumed that once students have a good basic understanding of relevant strategies, they are all set, but this is not the case. Many students are not able to apply effective learning strategies when they are needed, and thus give up in the face of difficulty (Winne & Jamieson-Noel, 2002). In other words, those students who cannot realize adaptive regulation fail (Boekaerts & Corno, 2005).

Recently, in research on self-regulated learning (SRL), there has been an ongoing discussion about the social aspects of SRL. Earlier mainstream SRL models focused heavily on the *individuals as regulators* of behavior and examined how social context plays a role in the generation of cognition and the pursuit of personal goals (Boekaerts, Pintrich, & Zeidner, 2000). The model suggests that even if SRL can be assisted by external modeling and feedback, it develops within each individual. Another approach is to frame regulation process by using the notion of shared cognition and recent research on collaborative learning (Järvelä & Hadwin, 2014). The idea is, in essence, that shared understanding is co-constructed (Roschelle & Teasley, 1995), and thus requires collective regulation, in which groups develop a shared metacognitive awareness of goals, progress, and tasks, thereby *sharing regulation* processes as a collective (A. Hadwin & Oshige, 2011; Järvelä & Järvenoja, 2011).

Methods and participants

This study followed the principles of the design based research (DBR) method (Brown, 1992), and by approaching the research from design-based research perspective the aim was to conduct design and pedagogical interventions in formal educational settings and to study the effect of the interventions on learning events. Mixed methods have been employed, such as qualitative analysis of data gathered from mathematics education lessons, collaborative group work and analyses of the server logs generated by the use mobile SRL apps and other tools.

Participants and context

The participants were 44 undergraduate students (36 females and 8 males, mean age 24.9 years) enrolled on a five-year primary teacher education program at the Faculty of Education at a Finnish university. All of the students were enrolled on a compulsory course titled "Mathematics education, part II" during the spring semester of 2014. The participants worked in groups of three to four students for 8 weeks. Groups were divided into high, mixed and low regulators based on their individual scores in the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & Mckeachie, 1993). The pedagogical design of the mathematics education course consisted of lessons and collaborative group tasks. Each of the lessons involved a small collaborative group task. The students worked in the same four-member groups to complete both the lecture assignments and the course assignment. All together there were eleven collaborative groups. Both lessons and group tasks took place at the LeaForum interaction laboratory, which is a versatile teaching and observation facility equipped with various modern devices (internet tablets, interactive video projectors etc.) and flexible fittings to provide for different group compositions.

Pedagogical design for socially shared regulation of learning

In the context of the mathematics education course, a prototype regulation tool (S-REG) and Google Docs were used as learning tools, and tablet computers as devices during the lessons and collaborative tasks (see Figure 1). Students were offered guidance for using the S-REG regulation tool and Google Docs. In order to introduce the main principles of self-regulated learning at the start of the math lessons a short newsflash was given at the beginning of every lesson.

1. **Mathematics education lesson** (8 x 2 hr mathematics education topics): (see also Figure 1)

   A. *News flash* [coaching in self-regulated learning]: In this phase different SRL topics were introduced to the students

   B. *Grounding* [introduction to the topic]: Each of the eight course weeks started with an introduction to a topic, in which students were grounded in main concepts related to mathematics education. The specific themes were in the following order: 1) introduction to the course, 2) approximation and mental calculation 3) teaching percentages 4) assessment and evaluation 5) problem solving 6) teaching algebra 7 and 8) coursework presentations.

   C. *Regulation phase* [increasing awareness of regulation]. Students used the S-REG tool to increase awareness of their regulatory processes and stimulate their cognitive, motivational, and emotional regulation to better achieve their learning goals.

   D. *Collaborative problem solving* [transferring knowledge to practice]. In this phase aim was to transfer mathematical knowledge to practice by solving problems connected to the lesson's topics in working groups.

2. **Coursework** (5 x 3 hr): Create a mid-term plan for mathematics:

   The groups were required to design a mid-term plan in the form of a Google Docs document by the end of the semester. Topics for the mid-term plans were: Numbers and calculations for the 6th grade (12–13-year-olds), Primary algebra and functions for the 5th grade (11–12-year-olds), Data processing and statistics for the 6th grade, Geometry and measurement for the 4th grade (10–11-year-olds), Numbers and calculations for the 4th grade. The students chose more refined topic from these larger topics. In order to complete mid-term plan project, the students needed to write two documents: a planning document and a mid-term plan document. The mid-term plan consisted of six sections: 1) Introduction and theoretical framework, 2) Aims of the plan and description of how the school curricula will be used in the plan 3) Evaluation of learning materials 4) Assessment plan 5) Planned lessons 6) Bibliography. The pedagogical design of the group task was as follows: (see also Figure 1)

   A. *Planning phase* [promote SSRL and keep track of the process]: In the first meeting groups created socially shared planning document (described in the tools section). This plan was revised a) after problems with group work and b) at the beginning of each collaborative group workshop

   B. *Regulation phase:* [increase awareness of regulation]. Students used the mobile regulation tool to increase their awareness of their own regulatory processes and stimulate their cognitive, motivational, and emotional regulation to better achieve their learning goals

   C. *Execution phase*: [task execution] in this phase the student groups did their group work: a mid-term plan for mathematics education.

   D. *Problem phase* (if any): If students had any problems with their task execution they were advised to carry out phases A and B again and then continue their task execution.

   E. *Execution phase* (continues after the problem phase and phases A and B): [task execution] in this phase the student groups concentrated on their group work: a mid-term plan for mathematics education.

Tools to support socially shared regulation of learning

In this study the design of the S-REG tool and the Google Docs planning template followed three design principles for supporting SSRL (as presented in Järvelä et. al (2014)): awareness, externalization and promoting regulation. The design of the S-REG tool and the use of Google Docs as a planning tool reflect experiences gained in the first design cycle where the VCRI tool was used to support SSRL activities.

   Google Docs as socially shared planning tool. The collaborative task included a planning phase (see Figure 1) in which group members created (new plan) or revised (existing plan). In this phase the group

members used a Google Docs template (see table 1) which prompted groups to identify and develop SSRL strategies (Järvelä et. al, 2014).
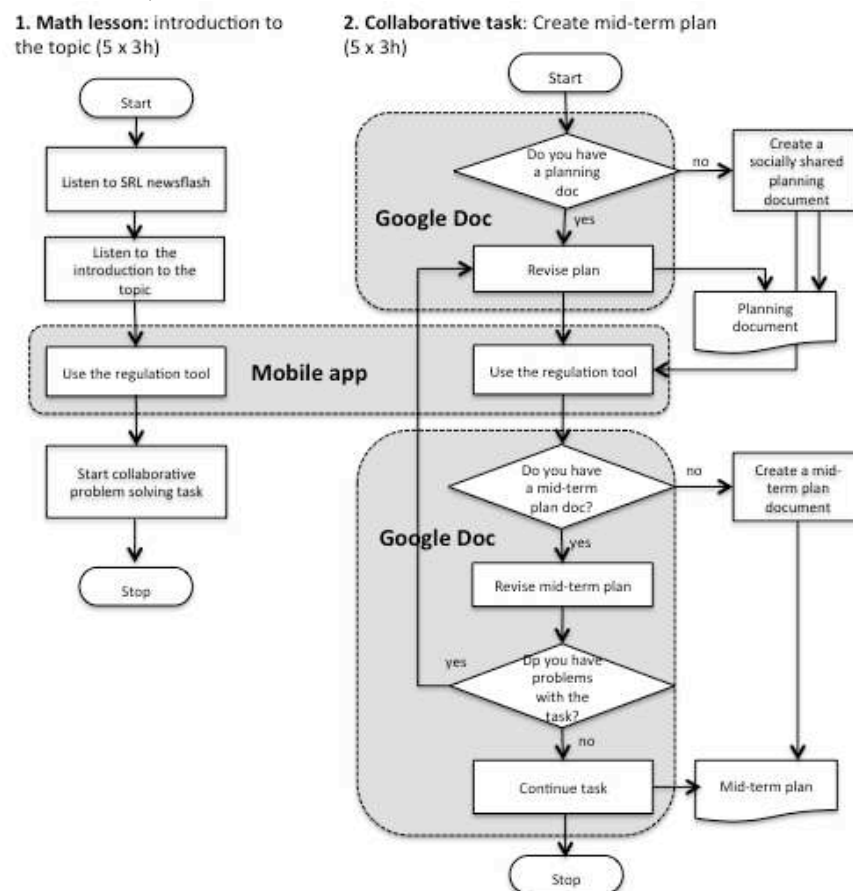

Figure 1. Task flow during the course. Left: Math lesson. Right: Collaborative group task

Table 1: Questions in the socially shared planning document template tool

#	Primary question in template	Theory
1	Describe the topic and the structure of your mid-term plan	Task understanding
2	What issues do you need to consider for planning your mid-term plan?	Task understanding
3	How you will structure your work? What concrete steps and targets will you use?	Planning and goal setting
4	How you will organize your work?	Strategy use
#	Additional questions in the template	
1	How challenging does your group think this task is? Explain why?	Internal task conditions
2	What is your goal for this group work exercise?	Goal setting
3	How are you going to work as a group to achieve this goal?	Strategy for collaboration

The S-REG mobile web app is a simple and responsive HTML5 application which was designed to run on smartphones, tablets and desktops, unlike the VCRI tool, which was limited to desktop computers running Microsoft Windows. S-REG uses Google API for Oauth 2.0 authorization. In practice students were provided with a seamless user experience, with Google Docs used for planning and S-REG for supporting individual group members' awareness; externalization of motivational, emotional and cognitive aspects; and prompting groups' socially shared regulation. Both task types (mathematics lesson and collaborative task) included a phase(s) (see Figure 1) in which the regulation tool was used to support SSRL. The activity flow when using S-REG consists of five sections, which were shown to individual students after all group members had completed their respective activities in the current section (see Table 2).
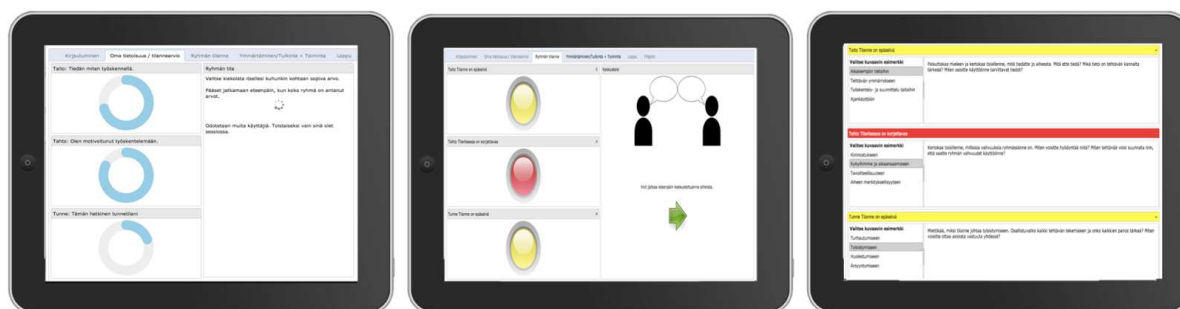
Figure 2. Left: Recognition of cognition/emotional/motivational status, Middle: Synthesis of group members'
responses, Right: Pre-stocked options for targeted regulation

Table 2: User interface sections of the regulation tool

Section	User interface component(s)	Definition for component	Level	Phase
Frontpage	User login, task selection	User and context identification	Individual	-
Individual status	Three rounded sliders (cognition/motivation/emotion)	Recognition of cognition/motivation/emotion	Individual	Self-awareness
Group status	Three color indicators (available colors: red, yellow, green)	Synthesis of group members responses [If lowest between 0–33 then red If lowest between 34–66 then yellow If all 67–100 then green]	Group	Group-awareness
Group prompt	Image: two persons talking	Discussion – What is the reason for your group color?	Group	Reflection
Action prompt	Pre-define options for the targeted regulation	When the color is red or yellow there will be a list of options to label the main reason coming up in a group discussion. When the color is green there will be an open space to specify the reason.	Group	Reflection
Action prompt	Regulation prompt	Targeted feedback about regulation possibilities	Group	Adaptation of appropriate Regulation

Data collection

The data consists of self-reported data (i.e. questionnaires and interviews), time based sampling data (i.e. log data) and the learning results collected in the context of the mathematics course.

- **MSQL questionnaire data from previous design cycle**: Existing MSQL questionnaire data was collected from the students prior the course.

- **Students' products collected for learning assessment**: All products created in student groups were collected not only for research purposes, but also for students' learning assessment. This data consists of two self-evaluation questionnaires, mid-term plans (coursework) and voluntary extra calculations.

- **Interviews conducted after the course**: The interview data consisted of 43 interviews, on average 15–20 minutes, which were conducted at the end of the course.

- **Log-files generated by use of the S-REG tool**: Use of log-file data produced by the S-REG tool, which included: 1) activity path [students actions within the UI] 2) values entered by subjects: a) session selector [lesson/coursework]; b) rounded SRL-dials [cognition, motivation, emotion]; c) textboxes [explanation for green color]; d) list menu [SRL-prompt chosen from the suggested list of prompts].

Data analysis

- **MSQL data was used for grouping the students**: In the context of this paper MSQL data (which was already processed in an earlier design cycle) was used to choose and contrast a group of low-regulating students against a group of high-regulating students.
- **Scoring procedures for the assessment data:** The course grade for students s was given using the sum Grade(s) = midterm plan(s) + self-evaluation(s) + voluntary calculations(s). The *Midterm plan* was graded from 0 to 3 by the math teacher. *Self-evaluation* was the students own assessment, dealing with topics such as "I can explain what is the most important issue in teaching percentages? Why?" (this was asked in the questionnaire, using the likert-scale). The *math calculation* was a voluntary task which was graded as either pass or fail (this task dealt with the topics presented during the lectures).
- **Log-files:** Log-file data was exported from the S-REG tool in Excel-format. Although the log-files had fine-grained data about individual students' actions, only group level values were calculated for this paper.
- **Interviews**: The interview data was transcribed and analyzed in order to explore students' opinions on how the S-REG tool supported their learning activities. In the excerpt from the interviews which was used in this paper, students were asked to rate the S-REG tool on a scale of 0–10 and explain how it supported their group during the course.

Results

Assessment and MSQL scores

Assessment and MSQL scores (see table 3) were used to choose and contrast low and high regulating group in the comparison of the usefulness of the S-REG-tool. Based on the results, group B3 was chosen as the low regulating group, because both their course average score and their MSQL average were the lowest on the course. Group A1 was chosen to be the high regulating group because their MSQL average score was highest.

Table 3: Assessment and MSQL questionnaire average scores at group level

Group	MSQL (avg)	Self (avg) [0-2]	Teacher (avg) [0–3]	Exercise score (avg) [0–1]	Course score [0–5(6)]
A1	**424**	1.8	3	0.3	5
A2	397	2	3	0.5	5.5
A3	360.5	1	3	1	4.8
B1	400.8	1.8	2.3	1	5
B2	355.8	1.5	2.3	1	5
B3	**323.3**	1.3	**2**	0.3	**3.5**
C1	399	1.7	3	0.7	5.3
C2	355	1.8	3	0.5	5.3
C3	346	2	3	0.5	5.5

Differences in the synthesis of the cognitive, motivational and emotional states between high and low regulating groups

Table 4 shows the differences in cognition, motivation and motivation between a group of high-regulators (group A1; avg MSQL score 424(24.83)) and a group of low-regulators (group B3; avg MSQL score 323.3(5.74)). The synthesis of group members' responses (collected from the problem solving task in the math lessons) suggests that students who had a low score in the MSQL test also had lower group level cognitive, motivational and emotional values from the S-REG tool. However, as table 4 shows, both groups got yellow or red values each time while they were using the tool.

Table 4: Topics of mathematics lessons and group level values from the S-REG tool

Group	#	Inspiration Talk Topic	Topic	Need for regulation	Cognition	Motivation	Emotion
A1	1	Tool introduction	First lecture	R+	Red	Yellow	Red
A1	2	Collaborative learning	Approximation & Mental Calculation	R+	Green	Yellow	Yellow
A1	3	Motivation	Teaching percentages	R+	Green	Yellow	Yellow

Group	#	Inspiration Talk Topic	Topic	Need for regulation	Cognition	Motivation	Emotion
A1	4	Emotion	Assessment & evaluation	R-	Green	Green	Yellow
A1	5	Cognition	Problem-solving	R+	Green	Red	Red
A1	6	Wrap up	Algebra	R-	Green	Green	Red
			Average:	R+	Green	Yellow	Yellow
B3	1	Tool introduction	First lecture	R+	Red	Red	Red
B3	2	Collaborative learning	Approximation & Mental Calculation	R+	Red	Red	Red
B3	3	Motivation	Teaching percentages	R+	Green	Yellow	Yellow
B3	4	Emotion	Assessment & evaluation	R+	Yellow	Red	Red
B3	6	Wrap up	Algebra	R+	Green	Red	Red
			Average:	R+	Yellow	Red	Red

Students' opinions about how the use of S-REG tool supported their learning activities

The results from the interviews reveal that students in the high regulating group show the potential of the S-REG tool for supporting socially shared regulation in their activities, but low regulating students felt that it was more of a joke than a useful learning tool.

> "My score for the app is 9. It forced us to think about our emotions and intents regarding the task. It forced me to think about my emotions and to regulate the task" (Iris. Group A1, MSQL 417, course grade 5, app evaluation 9)
> "Score is 7. It was a bit dull, but it forced us to think and discuss topics that are not normally discussed at all." (Julia, Group A1, MSQL score 416, course grade 5, app evaluation 7)

> "Maybe it did support our learning. Maybe not. We already knew each other's emotions, motivations etc. After brief discussions we knew what was going on. I don't think that it supported us." (Aleksi, Group B3, MSQL 326, course grade 4, app score: 8)

> "Well it was interesting to know fellow students' feelings. It sometimes made me change my own feelings. But quite often it was just joke, we just filled in the values and then continued with our task. We got bored very quickly" (Juliaana, Group B3, MSQL 315, course grade 2, app evaluation 6).

Members of both groups argued that the S-REG tool was used only at the beginning of the activity, which rendered it quite useless. This finding supports the idea that a change of design to suit learning activities would increase the frequency of tool use.

> "I didn't feel that it was important. It was filled just at the beginning of the lesson" (Juliaana, Group B3, MSQL 315, Course grade 2, app evaluation 6)

> "My grade for the app is only 7 because it was just used very briefly and rapidly. It was only a quick phase that had to be completed before starting the real tasks" (Julia, Group A1, MSQL score 416, Course grade 5, app evaluation 7)

> "Well, it had a lot of good functions, but I felt that it wasn't an interesting application, it was just something to be completed and that's all. But still I want to give 9 because it made me think about emotions and intentions" (Iris. Group A1, MSQL 417, Course grade 5, app evaluation 9)

Discussion

The aim of this paper was to describe how simple SRL tools can be used for supporting collaborative learning in the context of a mathematics education course. First, the pedagogical design presented may help other scientists and educators to create designs for collaborative learning which follow the theoretical framework of SSRL.

Second, the tools used in this study were off-the-shelf social media tools (Google Docs) and simple HTML5 based www-apps (S-REG) which can easily be customized in order to suit different types of pedagogical designs. In this study, these tools were used at different points of the collaborative tasks to increase teacher and student awareness of situation-specific regulation. Earlier research has shown that students who receive support for their regulated learning tend to learn better in comparison to students who do not receive support (Azevedo et al., 2012). However, the results indicate that the students' SRL skills determine the added value of the S-REG tool. Therefore, the importance of pedagogical design is key in enhancing skills for regulated learning.

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